The 5-Item Modified Frailty Index Independently Predicts Morbidity in Patients Undergoing Instrumented Fusion following Extradural Tumor Removal

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Abstract:

Introduction: The management of spinal neoplasia consists of surgical, radiation, and systemic options. Little data exist to guide management based on overall health status, which is particularly challenging when patients who could benefit from surgery may be too frail for it. This study's objective was to evaluate the 5-Item Modified Frailty Index (mFI-5) as a predictor of 30-day morbidity in patients undergoing instrumented resection for metastatic extradural spinal tumors.

Methods: Adults undergoing extradural tumor resection from the 2011 to 2019 National Surgical Quality Improvement Program datasets were identified by Current Procedural Terminology codes 63275-63278 with an adjunct instrumentation code (22840-22843). Patients were classified into frailty levels 0, 1, or 2+ based on mFI-5 scores of 0, 1, or 2-5, respectively. The primary outcome was morbidity. Secondary outcomes were readmission and reoperation. Multivariate modeling was utilized to analyze mFI-5 as a predictor of outcomes. The Akaike information criterion (AIC) was used to compare relative-model-fit based on frailty versus individual comorbidity variables to determine the optimal model. Chi-squared and Fisher's exact tests were used to establish significance between individual complications and frailty.

Results: There were 874 patients. Readmission, reoperation, and morbidity rates were 19.5%, 5.0%, 52.3%, respectively. In multivariate analyses, mFI-5=1 (OR: 1.45, SE: 0.31, p=0.036), mFI-5=2+ (OR: 1.41, SE: 0.40, p=0.036), operative time (OR: 1.18, SE: 0.03, p≤0.001), and chronic steroid use (OR: 1.56, SE: 0.42, p=0.037) independently predicted morbidity. Elective surgery (OR: 0.61) was protective. Frailty did not predict readmission or reoperation. Frailty was found to be significantly associated with respiratory complications, urinary tract infections, cardiac events, and sepsis/septic shock specifically.

Conclusions: mFI-5=1 independently predicted 45% increased odds of morbidity. mFI-5=2+ independently predicted 41% increased odds of morbidity. Further, every 30 additional minutes of operative time predicted 18% increased odds of morbidity, suggesting an increased risk of site-related complication events. Taken together, the mFI-5 serves as a valid predictor of morbidity in patients with extradural tumor undergoing instrumented excision.

Keywords:

Frailty, Modified Frailty Index, mFI-5, Spinal Tumor, Extradural Tumor, Metastatic Tumor, Risk Stratification, Predictor

Spine Surg Relat Res 2023; 7(1): 19-25

dx.doi.org/10.22603/ssrr.2022-0102

Introduction

Spinal tumors are a key contributor to the mortality and morbidity of patients with cancer. Estimates as high as 70% indicate that patients with systemic neoplasia harbor secondary spinal metastases at the time of autopsy[1]. Around 18,000 metastatic cases to the spine are diagnosed in North America every year[2]. This number is ever-growing as new developments have significantly prolonged the survival time of patients with cancer. Primarily lesions represent only ～10% of spinal tumors in comparison to the vast majority by metastatic spread[3]. For these reasons, metastatic spinal tumor management is of particular importance in mitigating damage to patients with cancer of all kinds.

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Received: May 13, 2022, Accepted: June 27, 2022, Advance Publication: August 23, 2022

Nonetheless, the management of metastatic spinal tumors presents a host of difficult challenges for the physician to navigate. For one, surgical intervention of the spine is complex and holds a substantial risk of vital and neural complications[4,5]. Furthermore, the supplemental chemotherapy, radiation, and spinal reconstruction that often comes with spinal tumor resection make postoperative complication rates higher than in any other type of spine surgery[1,6-10]. With this in mind, surgeons are being challenged to consider other forms of management with far fewer risks for the palliation of symptoms and prolongation of survival. Given this, a predictive tool to better assess the preoperative risk of surgery and better inform decision making in this patient population is needed.

One metric that has been attracting substantial attention is frailty. The 5-item Modified Frailty Index (mFI-5) is of particular interest given its conciseness and usability with the variables listed in the National Surgical Quality Improvement Program (NSQIP) database, making for easy use by clinicians and researchers alike[11]. The mFI-5 generates a frailty score based on the absence or presence of five comorbidities[12] (Appendix A). This index has been proven to be a strong predictor of postoperative adverse outcomes in surgeries for cervical myelopathy, elective posterior lumbar fusions, and kyphoplasties[12,13]. Despite its potential to serve as a common clinical tool, its value in predicting outcomes following metastatic extradural tumor removal has not yet been fully elucidated. In this study, we evaluate the utility of the mFI-5 as a predictor of morbidity following metastatic extradural spinal tumor resection with instrumented fusion and, specifically, the types of complications it predicts. Further, we evaluate the mFI-5 as a predictor of readmission and reoperation in these patients.

Materials and Methods

Data collection and inclusion criteria

The American College of Surgeons' NSQIP database is a prospectively collected database that collects records from randomly selected patients across >700 hospitals for >1 million cases annually. More than 150 variables are collected, including demographics, comorbidities, intraoperative variables (e.g., OR time, intra-op labs), and 30-day postoperative outcomes. The NSQIP dataset encodes surgical procedures by Current Procedural Terminology (CPT) codes and diagnoses by the International Classification of Disease, Ninth/Tenth Revision, Clinical Modification (ICD-9/10-CM) codes. Quality and accuracy are maintained by Surgical Clinical Reviewers and interrater reliability audits. All patient information in the NSQIP is deidentified, therefore making this study exempt from Institutional Review Board approval.

CPT codes were used to search the NSQIP database for patients undergoing removal of extradural tumors from 2011 to 2019. All identified patients meeting the inclusion criteria were included for further analyses (Appendix B). Exclusion criteria was also applied (Appendix B).

Frailty index and outcomes definitions

Total mFI-5 scores were calculated with the five relevant NSQIP-provided variables. Scores for each patient were summed for a total between 0 and 5. Based on previous literature, patients included for final analyses were categorized into three groups for comparison: (1) mFI-5=0; (2) mFI-5=1; and (3) mFI-5=2+.

The NSQIP reports 30-day complication data for each patient. The 30-day morbidity was calculated using the NSQIP complication variables. These complications include superficial infections, deep infections, pneumonia, renal failure, pulmonary embolism, cardiac arrest, sepsis, and septic shock, among others. If any postoperative complication was present, the patient received a morbidity score of 1; if none were present, the patient received a score of 0. The 30-day readmission and reoperation variables are also reported in the NSQIP database and were collected to be used for analyses.

Statistical analyses

Descriptive statistics, including the mean and standard deviation for continuous variables and frequency and proportion for categorical variables, were calculated to characterize the cohort. Differences in baseline characteristics between those with and without a postoperative complication were compared with independent t-tests, chi-squared tests, or Fisher's exact test, where appropriate. Multivariate models for morbidity, readmission, and reoperation were constructed following a structured approach. Multiple logistic regression models were fit to sociodemographic data, followed by the addition of frailty and perioperative variables. This process was repeated with the comorbidity variables, leaving frailty out of the models. In both cases, variable selection was based on factors considered to be risk factors for morbidity. The Akaike information criterion (AIC) was used to compare the relative fit of a model based on frailty versus a model based on the comorbidity variables. Both model complexity and AIC values were used to determine the optimal model, with a difference in AIC >2 indicating a meaningful difference in support. Results are presented as odds ratios (ORs) with corresponding 95% confidence intervals. Models were constructed using the R program and *glm* package (version 3.4.3, R Foundation for Statistical Computing, Vienna, Austria).

To better characterize which complications were influenced by frailty, complication outcomes as listed in the NSQIP database were categorized into 10 groups: wound infections, wound disruption, respiratory complications, thrombotic events, renal complications, urinary tract infection (UTI), stroke/cerebrovascular accident (CVA), cardiac events, bleeding requiring transfusion, and sepsis/septic shock. A chi-squared test was used to ascertain a statistically significant correlation between the three aforementioned frailty levels and the incidence of these complication groups. However, in the case of complication types with low incidence rates (five or fewer patients in at least two frailty levels), Fisher's exact test was utilized because of the decreased accuracy of the chi-squared test under these statistical circumstances. Analyses were carried out using the R program.

Results

Univariate analyses

Following the application of inclusion and exclusion criteria, the NSQIP database yielded 874 patients who underwent instrumented extradural tumor resection. The majority of patients were male (61.0%) and white (81.8%), with a mean age of 61.1 years. The average patient was overweight (body mass index (BMI)=25-29.9 kg/m^2), with a mean BMI of 27.7 kg/m^2. The number of patients in each mFI-5 category were 395 (45.2%), 326 (37.3%), and 153 (17.5%) for mFI-5 of 0, 1, and 2+, respectively.

Univariate analyses revealed several variables that were significantly ($p<0.05$) associated with morbidity at baseline (Table 1). Elective *vs.* nonelective surgery, BMI, ASA ≥ *vs.* <3, operative time, and length of hospital stay were all found to be significantly associated with morbidity, among others, before adjustment. Notably, mFI-5=0, mFI-5=1, and mFI-5=2+ were not found to be significant in predicting morbidity at baseline, prior to adjustment.

Multivariate analyses

Multivariate logistic regression analyses demonstrated an increase in morbidity in patients with an mFI-5 level of 1 as compared to 0 (OR: 1.45, SE: 0.31, p=0.036). The same model demonstrated an increase in morbidity in patients with an mFI-5 level of 2+ as compared to 0 (OR: 1.41, SE: 0.40, p=0.036). Multivariate analyses further demonstrated that elective surgery (OR: 0.061, SE: 0.012, p=0.004), increasing OR time (OR: 1.180, SE: 0.03, p≤0.001), and chronic steroid use (OR: 1.56, SE: 0.42, p=0.037) predicted morbidity (Table 2).

Multivariate logistic regression demonstrated no significance in readmission or reoperation between mFI-5 levels 1 and 2+ as compared to 0.

The AIC was analyzed to determine which model best fits the data. The AIC for the model based on frailty was calculated to be 1012.1, whereas the AIC for the model based on the mFI-5 comorbidity variables was calculated to be 1015.4.

Chi-squared test and Fisher's exact test

The observed rates of the different complication types as listed in the NSQIP are noted (Table 3). Expected values were calculated and recorded (Table 4).

Chi-squared tests and Fisher's exact tests were used on an individual complication category basis to better illustrate the correlation of frailty with each different complication type. Notably, wound disruption, renal events, stroke/CVA, and cardiac events had very low incidence rates, necessitating use of Fisher's exact test because of the reduced efficacy of the chi-squared test when incidence counts are fewer than 5 in more than a single category. These statistical tests established significance ($p<0.05$) between some individual complication groups and frailty, including respiratory complications, UTI, cardiac events, and sepsis/septic shock. These analyses demonstrated no significance between the other complication groups and frailty (Table 5).

Discussion

Our analyses sought to illustrate the ability of the mFI-5 in predicting morbidity following instrumented metastatic extradural tumor resection. After controlling for the patient-related and procedural factors found in Table 2, we found that a mFI-5 of 1 independently predicted 45% increased odds of morbidity as compared to the control (mFI-5 of 0) and that a mFI-5 of 2+ predicted 41% increased odds of morbidity as compared to the control (mFI-5 of 0). Given that the AIC for the model based on frailty (1012.1) was smaller than the model based on the mFI-5 comorbidities (1015.4) and that there was a difference >2, there is evidence of a better fit from the frailty model to the data and a meaningful difference between the two regression analyses.

Although it is common sense that patients with comorbidities are at an increased risk of complications, such a markedly elevated risk with just one of the five comorbidities making up this index is of significance. These findings suggest that frailty is a strong predictor for morbidity in this patient population. However, given the risk of complication with one comorbid condition, intuitively, one would theorize that additional comorbidities should further increase the risk of complication. Nonetheless, this was not supported by the data. The apparent reversal of the expected ORs may be explained by the possibility that several comorbidities do not confer any more risk than just one. Or it may be explained by the low number of patients in the mFI-5=2+ category. Lastly, the difference between the theorized trend in ORs and the trend observed may be best explained by the limitations of the mFI-5 index. It is likely these patients had other medical conditions not captured by the mF-5 that may be obscuring the data and subsequent results.

We also found that elective surgeries of this nature as compared to nonelective surgeries were significant predictors of postoperative morbidity, decreasing the risk by 39%. This may be a result of the acuity of treatment (or lack thereof) and/or the condition of elective *vs.* nonelective patients with metastatic spread to the spine. Nonelective cases may have been in situations of acute cord compression due to the tumor itself or a tumor-related fracture, with retropulsion into the canal. Without specificity in the NSQIP database, we cannot know for sure. This unexplained finding is a limitation of this study.

Further, we found an 18% increased risk of postoperative

Table 1. Descriptive Statistics and Univariate Analyses of Patient Characteristics.

Patient Characteristics	Variable	Morbidity–No	Morbidity–Yes	p-Value
		Demographics		
Sex	Female (%)	173 (41.4)	168 (36.8)	0.191
	Male (%)	245 (58.6)	288 (63.2)	
Race	Non-White (%)	67 (16.0)	67 (14.7)	0.702
	White (%)	290 (69.4)	312 (68.4)	
Ethnicity	Hispanic (%)	26 (6.2)	31 (6.8)	0.793
	Non-Hispanic (%)	331 (79.2)	367 (80.5)	
Age (years)	Mean (SD)	60.9 (12.3)	61.4 (12.2)	0.561
BMI	Mean (SD)	28.2 (5.7)	27.1 (5.6)	**0.008**
		Comorbidities		
CHF	No (%)	417 (99.8)	450 (98.7)	0.126
	Yes (%)	1 (0.2)	6 (1.3)	
COPD	No (%)	399 (95.5)	428 (93.9)	0.371
	Yes (%)	19 (4.5)	28 (6.1)	
HTN	No (%)	232 (55.5)	232 (50.9)	0.193
	Yes (%)	186 (44.5)	224 (49.1)	
Diabetes	No (%)	369 (88.3)	395 (86.6)	0.526
	Yes (%)	49 (11.7)	61 (13.4)	
Functional status	No (%)	388 (92.8)	409 (89.7)	0.131
	Yes (%)	30 (7.2)	47 (10.3)	
Frailty	mFI-5=0 (%)	204 (484)	191 (41.9)	0.109
	mFI-5=1 (%)	148 (35.4)	178 (39.0)	
	mFI-5=2+ (%)	66 (15.8)	87 (19.1)	
ASA	<3 (%)	354 (84.7)	424 (93.2)	**<0.001**
	≥3	64 (15.3)	31 (6.8)	
Weight loss	No (%)	398 (95.2)	406 (89.0)	**0.001**
	Yes (%)	20 (4.8)	50 (11.0)	
Ventilator	No (%)	417 (99.8)	447 (98.0)	**0.022**
	Yes (%)	1 (0.2)	9 (2.0)	
		Perioperative		
Elective	No (%)	261 (62.4)	344 (75.4)	**<0.001**
	Yes (%)	157 (37.6)	112 (24.6)	
Preop sepsis	No (%)	393 (94.0)	407 (89.3)	**0.016**
	Yes (%)	25 (6.0)	49 (10.7)	
Preop transfusion	No (%)	413 (98.8)	437 (95.8)	**0.007**
	Yes (%)	5 (1.2)	19 (4.2)	
Emergency	No (%)	364 (87.1)	374 (82.0)	**0.049**
	Yes (%)	54 (12.9)	82 (18.0)	
Operative time	Mean (SD)	7.3 (2.9)	8.9 (3.8)	**<0.001**
LOS	Mean (SD)	9.0 (6.2)	12.5 (9.1)	**<0.001**
Discharge disposition	Home (%)	262 (62.7)	196 (43.0)	**<0.001**
	Rehab (%)	150 (35.9)	234 (51.3)	**<0.001**
		Preoperative labs		
INR	Mean (SD)	1.1 (0.1)	1.1 (0.2)	**0.003**
HCT	Mean (SD)	38.1 (5.1)	35.2 (5.5)	**<0.001**

Bold p-values are statistically significant (p<0.05). BMI: Body Mass Index; CHF: Congestive Heart Failure; COPD: Chronic Obstructive Pulmonary Disease; HTN: Hypertension; ASA: American Society of Anesthesiology Score; LOS: Length of Stay; INR: International Normalized Ratio; HCT: Hematocrit

morbidity for every 30 additional minutes of operative time. This is likely due to the increased infection risks conferred by the lengthened OR time. Moreover, the operative time likely increases proportionally with tumor size. A larger neoplasm may result in greater bleeding risk, requiring transfusion or larger surgical wounds with an increased risk of disruption which may also explain this finding. Additionally, we found that steroid use for chronic conditions prior to surgery was also a significant predictor of morbidity, best explained by steroids' adverse effects on bone density.

It is also of note that neither an mFI-5 of 1 or 2+ was significantly associated with readmission or reoperation. The complexity of patients with cancer and their management likely contributes to this insignificance. Additionally, we would expect that this population in particular has high rates of readmission and reoperation for reasons not related to their spinal tumor resection. As the NSQIP variables do not specify why patients seek readmission or reoperation, it is fair to assume that unassociated instances of additional care that do not relate to the patients' frailty as described by the mFI-5 are captured in this dataset. This is another limitation of this study.

Additionally, the chi-squared analyses and Fisher's exact tests used to determine whether frailty is a significant predictor of the development of a given complication group showed that respiratory complications, UTIs, cardiac events, and sepsis/septic shock are significantly influenced by frailty. Although it is difficult to determine why some complications were statistically influenced by frailty and others not, we appreciate the limitations of small sample sizes and encourage future research to identify a greater number of patients with morbidity. Higher powered studies, for example, may find significant differences for other complication categories not observed in these data. Nevertheless, frailty should be considered in patients undergoing extradural tumor resection. Admission to higher observational units, such as the ICU or sub-ICU, postoperatively for patients with mFI-5s >0 should be considered to better mitigate morbidity.

Our results add to the emerging body of evidence that the mFI-5 is a useful predictor of postoperative outcomes in spine surgery and orthopedics at large. Weaver et al. found that the mFI-5 was successful in predicting postsurgical complications and outcomes in frail patients who had undergone elective posterior lumbar fusions[13]. Further, Segal et al. concluded that there is a significant correlation between frailty and adverse outcomes after kyphoplasty[12]. Moreover, Zreik et al. established that the mFI-5 is significantly associated with 30-day adverse outcomes following anterior cervical discectomy and fusion[14]. Although it has fallen out of favor because of its difficulty implementing clinically and its lack of synchrony with the NSQIP database, others have proven the predictive value of frailty by utilizing the 11-Item Modified Frailty Index in spine surgery and orthope-

Table 2. Multivariate Logistic Regression Analyzing Predictors of Morbidity.

Independent variable	Odds ratio	Standard error	p-Value
Demographics			
Age	1.00	0.01	0.869
Sex (males)	1.38	0.27	0.052
BMI	0.96	0.01	**0.004**
Comorbidities			
mFI-5=1	1.45	0.31	**0.036**
mFI-5=2+	1.41	0.40	**0.036**
Weight loss	1.38	0.61	0.297
Smoker (yes)	1.18	0.29	0.411
Steroids (yes)	1.56	0.42	**0.037**
Perioperative			
Preop transfusion	1.71	2.01	0.336
Elective (yes)	0.61	0.12	**0.004**
Operative time	1.18	0.03	**<0.001**
Preoperative labs			
Creatinine	0.90	0.18	0.510
WBC	1.03	0.02	0.136
HCT	0.90	0.01	**<0.001**

All listed variables controlled for in the multivariate model. Bold p-values are statistically significant (p<0.05). BMI: Body Mass Index; WBC: White Blood Cells; HCT: Hematocrit

Table 3. Observed Incidence of Complication Categories among the Three Frailty Groups.

	mFI-5=0	mFI-5=1	mFI-5=2+	Total
Wound infection	14	10	9	33
Including superficial wound infection, deep incisional SSI, organ/space SSI				
Wound disruption	5	1	1	7
Respiratory	21	19	19	59
Including pneumonia, unplanned intubation, ventilator >48 hours				
Thrombotic events	31	22	12	65
Including pulmonary embolism, DVT				
Renal events	0	2	2	4
Including progressive renal insufficiency, acute renal failure				
UTI	8	11	10	29
Stroke/cerebrovascular accident	1	3	1	5
Cardiac events	1	9	4	14
Including cardiac arrest requiring CPR, myocardial infarction				
Bleeding requiring transfusion	155	149	74	378
Sepsis & septic shock	8	9	12	29
No listed complication	152	96	11	259
Totals	396	331	155	882

All observed instances of complication categorized in groups among frailty groups. SSI: surgical site infection; DVT: Deep Vein Thrombosis; UTI: Urinary Tract Infection; CPR: Cardiopulmonary Resuscitation

Table 4. Expected Incidence of Complication Categories among the Three Frailty Groups.

	mFI-5=0	mFI-5=1	mFI-5=2+	Total
Wound infection	14.81633	12.38435	5.79932	33
Including superficial wound infection, deep incisional SSI, organ/space SSI				
Wound disruption	3.142857	2.626984	1.230159	7
Respiratory	26.4898	22.14172	10.36848	59
Including pneumonia, unplanned intubation, ventilator >48 hours				
Thrombotic events	29.18367	24.39342	11.4229	65
Including pulmonary embolism, DVT				
Renal events	1.795918	1.501134	0.702948	4
Including progressive renal insufficiency, acute renal failure				
UTI	13.02041	10.88322	5.096372	29
Stroke/cerebrovascular accident	2.244898	1.876417	0.878685	5
Cardiac events	6.285714	5.253968	2.460317	14
Including cardiac arrest requiring CPR, myocardial infarction				
Bleeding requiring transfusion	169.7143	141.8571	66.42857	378
Sepsis & septic shock	13.02041	10.88322	5.096372	29
No listed complication	116.2857	97.19841	45.51587	259
Totals	396	331	155	882

Expected instances of complication categorized in groups among frailty groups. SSI: surgical site infection; DVT: Deep Vein Thrombosis; UTI: Urinary Tract Infection; CPR: Cardiopulmonary Resuscitation

Table 5. Individual Chi-squared and Fisher's Exact Tests for Each Complication Group among Frailty Groups.

Complication category	p-Value
Wound infection	0.31
Wound disruption	0.64*
Respiratory	**0.0091**
Thrombotic	0.82
Renal	0.092*
UTI	**0.032**
Cerebrovascular accident	0.26*
Cardiac events/MI	**0.0028***
Bleeding requiring transfusion	0.11
Sepsis/Septic shock	**0.0025**

Frailty as an independent predictor of specific complication groupings. Bold p-values are statistically significant ($p<0.05$). Asterisks (*) indicate analysis with Fisher's exact test. UTI: Urinary Tract Infection; MI: Myocardial Infarction

dics[11,15-17]. Despite the overwhelming evidence of its predictive power, there are some instances where the mFI-5 index has been proven to be a poor prognostic tool. Elsamadicy et al., for example, found that frailty, as measured by mFI-5, does not significantly predict length of stay, 30-day adverse events, or 30-day unplanned readmission in patients undergoing lumbar spinal decompression and fusion for spondylolisthesis[18]. Thus, it is important to continue to assess the predictive value of the mFI-5 in various spine surgeries and otherwise.

Assessing surgical outcomes in the management of metastatic spread to the spine is important for clinical decision making − understanding postoperative complication risk is particularly useful for counseling and guiding treatment decisions in these complex surgeries and patients. Risk stratification can aid in proper patient selection. Although age has often been used as a measure of one's health, we now better understand that it does not always fully depict one's physiologic state. This is the niche that frailty has begun to fill in both current literature and clinical practice alike. Given that its predictive power has been proven in various orthopedic operations and that it can be easily applied in practice with the accessibility of the variables that make up the index, the mFI-5 is a strong clinical tool for orthopedists and spine surgeons. The risk of morbidity following extradural tumor resection can now be evaluated with more accuracy preoperatively.

This study has several limitations inherent to the database queried and otherwise. First, there is a possibility of ICD and CPT coding error and reporting biases. Second, the generalizability of our findings may be limited by the retrospective nature of the study. Additionally, unequal sample sizes in mFI-5 groups and possible confounders unaccounted for in the database may have obscured the results. Furthermore, morbidities characteristic of spine surgery, such as implant-related complications or neurological paralysis, are not recorded in the NSQIP database and therefore, cannot contribute to the computed morbidity scores. We recognize that without these outcomes accounted for in the dataset, true complication risk may be obscured and that morbidity rates may be understated. Finally, the NSQIP only records complication rates within a 30-day window, meaning that some cases of morbidity, readmission, and reoperation may have been missed given this limited timeframe. We encourage that more studies be conducted on the utility of the mFI-5 in predicting the postoperative morbidity, readmission, and reoperation in this patient population and others with a larger sample size and with complications characteristic of spine surgery accounted for. Regardless, the findings described throughout this study should shed some light on the predictive value of frailty, measured by the mFI-5 index, on postoperative complication rates.

Our study indicates that the mFI-5 is a strong predictor of 30-day complications following the resection of metastatic, extradural tumors with instrumented fusion. We found that, while adjusting for confounders, there was a 45% increase in morbidity of patients with an mFI-5=1 and a 41% increase in morbidity of patients with an mFI-5=2+ as compared to the mFI-5=0 control group. The mFI-5 is a straightforward risk stratification tool that can be used to correlate the physiologic condition of patients preoperatively with morbidity following surgical resection of the metastatic, extradural tumor. As it relies on readily accessible variables, it can be applied efficiently and effectively. Given its predictive value and ease of application, it would be no surprise to see the mFI-5 index become clinically commonplace, especially in the field of orthopedics and spine surgery.

Conflicts of Interest: Dr. Jeff Silber receives teaching fees for Stryker.

Dr. David Essig receives consulting fees for Stryker and DePuy.

For all remaining authors, none was declared.

Sources of Funding: No funding was received in connection to this study.

Author Contributions: A.S., A.K., M.S., S.S., J.S., R.V., S.V., J.S., and D.E. all provided contributions to the conception and design of the study. The authors all helped analyze data, draft the work, or provided critical revisions necessary for the conception of the research.

Ethical Approval: IRB approval not required for deidentified NSQIP research with no direct patient involvement.

Informed Consent: Consent was not required for deidentified NSQIP research with no direct patient involvement.

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